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THE ROLE OF RISK IN PILOTS' PERCEPTIONS OF PROBLEM SITUATIONS

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During the next decade, a number of dramatic changes are planned for the commercial aviation system. These changes will encompass both operational and technological advancements. One planned operational change of great potential significance is referred to as Advanced Air Traffic Technology (AATT) or "free flight" -- an advancement, which, when in place, will give airlines and flight crews more freedom in choosing and dynamically changing their optimal travel routes. Although free-flight has the stated goal of more flexibility of operations for commercial airlines while maintaining the highest levels of safety, it will necessarily require a much greater sharing of responsibility for safe use of airspace on the part of airline flight managers, air traffic controllers, and aircraft flight crews. The increased flexibility of free-flight suggests that flight crews may be faced with higher levels of workload and may be required to make more complex sequential and time-constrained dynamic decisions. With this increase in both number and difficulty of decisions comes the potential for decision related problems for commercial flight crews.

Flight-related problems that require some kind of crew decision making are already being reported with high frequency as incident reports to the Aviation Safety Reporting System (ASRS). These ASRS incident reports are extremely valuable because they can suggest situations or circumstances that are potentially problematic from a safety perspective and which might require operational changes on the part of the FAA, ATC, the airlines, or the flight crews. A significant number of these incidents appear to have high enough levels of safety risk or time pressure associated with them to produce difficulty in pilot decision making.

Research Efforts.

The effects of time pressure on decision making in flight settings, although not completely understood, has been the subject of a large amount of research in recent years and is an important component of models relating perceived workload to task performance. Perceived risk and its role in crew decision making, on the other hand, is not very well-defined and has not been systematically examined. The first summer of my fellowship was spent developing ways in which research in more traditional areas of decision making might be applied to aviation. This led to the re-analysis of data from an aviation decision making study that was conducted several years ago by NASA Ames personnel [1]. That re-analysis project has been completed this summer and will be summarized below. It will also be presented as a paper at the *Human Factors and Ergonomics Society Meetings* in September, 1996. A second project that examined pilots' perceptions of their most difficult flight decisions is also near completion. A third project under way is an in-depth analysis of 284 ASRS incident reports dealing with risky decisions and will be continued over the next year.

Summary of Project 1.

My colleague, Dr. Judith Orasanu, of the NASA Ames AFO Branch is one of a few researchers who have recently recognized the importance of perceived risk in pilot decision making and she has incorporated the construct into her model of aviation decision making. The study of risk poses some special problems for dynamic decision environments like flight, however. In a recent paper, Orasanu and NASA colleagues [1] examined whether perceived risk and time pressure, two important components of Orasanu's [2] model, are in fact relevant to pilots *judgments*. Participants in their studies sorted a representative set of 22 scenarios, taken from ASRS reports, into piles according to their similarity as decision problems. Using

an algorithm based on alternating least-squares multidimensional scaling (MDS) methodology, Fischer et al. [1] showed that, when pilots were asked to make this kind of undirected sorting, they differentiated between the decision problems on the basis of an "immediacy of potential risk" dimension and a "time pressure" dimension.

I wrote a computer program to re-analyze the data for each individual pilot separately and then attempted to compare the MDS scaling solution obtained from the directed sort of a second group of pilots' evaluations of the scenarios with respect to perceived riskiness, with the scaling solution that was based on the original group's undirected sort of the decision problems. It was hypothesized that if these two scaling solutions, one specific and one general, were to match, then there would be evidence to suggest that it is, in fact, perceived risk that primarily drives pilots' perceptions of flight decision problems, and that perceived risk is primarily a function of immediacy of potential risk and time pressure.

Method

Subjects. Two groups of twenty-eight pilots each from two major American airlines had served as volunteer participants in this study. The participants included approximate equal numbers of captains, first officers, and flight engineers.

Stimuli and Procedure. The same twenty-two brief scenarios were sorted by both groups of pilots. The scenarios were chosen to cover all aspects of flight; three scenarios were associated with pre-flight, two each with taxiing and descent, and four each with the takeoff, climb, and cruise phases of flight. One group of pilots was asked to make an undirected sort of the 22 scenarios by sorting them into as many or as few piles as necessary, such that those incidents that involved the same kind of major decision should be grouped together. Pilots were given no other instructions about using any specific criteria. In contrast, in the second study participants were asked to sort the scenarios specifically in terms of their perceived riskiness.

Results and Discussion

In the original aggregate group analyses done by Fischer et al. [1], a two dimensional MDS solution was obtained for captains, first officers, and flight engineers separately. Results indicated some group differences, but two primary dimensions emerged -- a time pressure dimension and a potential risk dimension with three categorical levels of risk -- no risk, immediate risk, and potential future risk.

We hypothesized that the directed sorting data for risk for the second group of pilots would match the undirected sorts of the first and this hypothesis was supported. A graphical picture of the two most important dimensions from the pilots' directed risk sort is shown in Figure 1 along with brief descriptions of the associated incidents. Dimension 1 was labeled "potential risk" and clearly resembled the comparable dimension found in the earlier study. Incidents were grouped as "no or low risk" incidents, incidents with risk immediacy (e.g., engine stall, smoke in the cabin, etc.), and incidents which have more future potential risk (e.g., landing gear problem detected while in cruise stage of flight). The second dimension seemed to indicate a distinction between high and low time pressure and matched very closely the time pressure dimension found in the undirected sort group's data.

The similarity of the observed two-dimensional cognitive maps for the two groups of pilots suggests that the categorization and evaluation of flight decision problems are heavily influenced by the perceived riskiness of the situation, and that risk, in turn, is to a large extent a function of the immediacy of the potential risk in the problem and time pressures associated with solving the decision problem. These results are important for aviation decision research for several reasons. First, they provide legitimacy to the inclusion of risk in models of aviation decision making. Second, they suggest that the construct of risk in dynamic decision tasks is not the same as in simple static decisions like those studied in gambling paradigms. Risk appears to be much more multidimensional in dynamic tasks. Future efforts will attempt to

look at pilots' perceptions of risk in more detail. We will continue to focus on the multidimensional nature of risk, the different types of perceived risk (e.g., professional, safety, economic), the impact of time constraints on risky decisions, and the impact of perceived risks on crew decision making.

References

[1] Fischer, U., Orasanu, J., and Wich, M. (1995). Expert pilots' perceptions of problem situations. *Proceedings of the Eighth International Symposium on Aviation Psychology, April 24-28, 1995.* Columbus, Ohio.

[2] Orasanu, J. (1994). Shared problem models and flight crew performance. In N. Johnston, M. McDonald, and R. Fuller (Eds.), *Aviation psychology in practice.* Avebury Technical.

Figure 1: Group Stimulus Space for Dimensions 1 (X-axis) and 2 (Y-axis).